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A Summary of Data from Vehicle Emissions Inspection Clinics held in Canada (1986 to 1990)

Report EPS 2/TS/7
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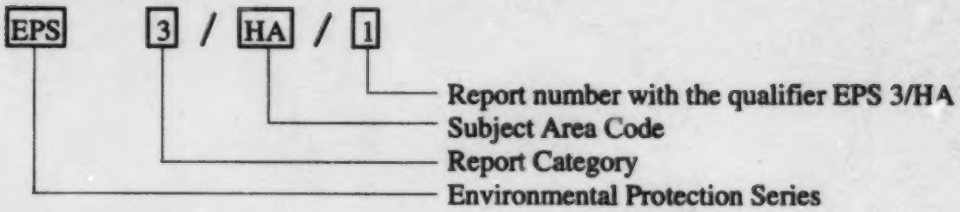

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A Summary of Data from Vehicle Emissions Inspection Clinics held in Canada (1986 to 1990)

by D. Cope

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Abstract

The emission component tampering rates and idle exhaust emissions data from 13 federal/provincial vehicle inspection clinics (held during 1986-1990) indicate problems with excess emissions from in-use vehicles in Canada.

Of the 2 884 vehicles inspected for emissions control system tampering, approximately 22% had at least one emissions component that was either missing, damaged or in some state of disrepair.

The overall tampering rate (which consisted mostly of removals) for catalytic converters was 10%. This level of tampering with this important emissions control device is serious and is equal to or higher than tampering rates recorded in the United States.

Idle exhaust emissions measurements were performed on over 3 000 vehicles at the clinics. Approximately 25% of the vehicles had carbon monoxide emissions that exceeded a set of relaxed pass/fail criteria and over 15% of the vehicles had hydrocarbon emissions in excess of a similarly lax criteria. Vehicles with emissions at either of these levels would have failed inspections in most inspection and maintenance programs now operating in the United States.

Excess emissions from in-use vehicles are a major source of air pollution in many urban centres in Canada. The data from these inspection clinics highlight the need for emissions control system anti-tampering legislation in all provinces. Where urban air quality is a concern, some form of enforcement program should be implemented to support the anti-tampering legislation.

Résumé

Les taux d'altération de dispositifs antipollution et les données relatives aux émissions du circuit d'échappement en régime de ralenti, provenant de 13 inspections fédérales-provinciales de véhicules automobiles (1986-1990), révèlent des problèmes d'émissions excessives par les véhicules automobiles du parc canadien.

Sur environ 22 % des 2 884 véhicules ainsi inspectés pour l'altération du système antipollution, au moins une composante de ce système était soit manquante, soit endommagée, soit plus ou moins en mauvais état.

Le taux global d'altération (soit principalement la dépose de pièces) était de 10 % pour les convertisseurs catalytiques. Le taux d'altération pour cet important dispositif antipollution est inquiétant; il est égal ou supérieur aux taux d'altération constatés aux États-Unis.

L'analyse des émissions du circuit d'échappement au ralenti a été faite sur plus de 3 000 véhicules automobiles lors des inspections. Environ 25 % des véhicules libéraient une quantité de monoxyde de carbone supérieure à une limite assouplie d'acceptation/rejet, et plus de 15 % des véhicules dégageaient une quantité d'hydrocarbures dépassant une limite tout aussi généreuse. Les véhicules dont les émissions se situeraient à l'un ou l'autre de ces niveaux limites auraient été rejetés dans la plupart des programmes d'inspection et d'entretien en vigueur aux États-Unis.

Les émissions excessives par les véhicules automobiles du parc canadien constituent une source importante de pollution de l'air dans beaucoup de centres urbains au Canada. Les données obtenues grâce à ces inspections mettent en lumière la nécessité d'une réglementation interdisant toute modification du système antipollution des véhicules automobiles dans toutes les provinces. Là où la qualité de l'air urbain représente un problème, un programme d'application devrait être mis en oeuvre pour faire respecter la réglementation sur l'intégrité des dispositifs antipollution.

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I also wish to thank the many provincial government personnel and Environment Canada regional staff who not only acted as members of the inspection teams but were also responsible for all local organization. Unfortunately, they are too numerous to list.

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Introduction

The federal government sets emissions standards for new light-duty* vehicles sold in Canada. All vehicle manufacturers are required to design vehicles which have emissions that comply with the levels of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), and for diesel-fuelled vehicles, particulates, as set forth in the government standards (Transport Canada and Environment Canada, 1989). Each vehicle, when sold and/or licensed for use on the roads and highways (referred to in this report as an "in-use" vehicle), should emit pollutants at or below the levels set out in the standards at the time of manufacture.

However, the emissions performance of a vehicle operated on the road is influenced not only by the vagaries of local weather but also by the owner's diligence in maintaining the vehicle. To ensure a vehicle operates as designed, it is important that all emission control equipment originally installed on the vehicle be left in place and all systems be maintained according to the manufacturer's specifications.

With respect to emissions, how well are vehicles in the Canadian in-use fleet maintained and operated? The federal and provincial governments have gathered data on the condition of in-use vehicles from both laboratory and field evaluations. Data from tests and surveys revealed that emissions from many in-use vehicles far exceed design levels. Field investigations have also shown that most of these excess emissions are a result of tampered emissions control systems, or insufficiently maintained vehicles (Cope, 1988a).

In Canada, since 1986, the field studies have been in the form of voluntary "inspection clinics". Although primarily designed as a public relations tool, these clinics have also been used to gather data for assessing the state of the in-use fleet. The purpose of this report is to present the data from the 13 clinics held from 1986 to 1990.

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* Revisions to the *Motor Vehicle Safety Act* on September 1, 1987 introduced stricter "light-duty" vehicle emissions standards and also changed the definition of such a vehicle to any vehicle with a Gross Vehicle Weight Rating (GVWR) of 3 855 kg (8 500 lbs) or less. Before that date, a light-duty vehicle was defined as a vehicle with a GVWR of 2 721 kg (6 000 lbs) or less.

Section 2

Background

For over 15 years, the voluntary "Vehicle Inspection Clinic" has been used by Environment Canada and provincial agencies as a means of establishing direct contact with the motoring public. Literature distributed at the clinics, along with associated media advertising and reporting, were used to inform the local motoring public about the purpose of emissions control systems, and of the environmental damage that can result from tampered or insufficiently maintained pollution control devices.

However, although the clinics are primarily a public relations tool, they are also used to gather data for assessing the state of the in-use fleet. Since 1986, these clinics have been presented as a media-advertised event that encourages local motorists to bring their vehicles to a well-known shopping centre for an inspection.

The 13 clinics described in this report are an outgrowth of the "Test and Tune Clinics" conducted in Canada from 1974 to 1984. The principal difference between the earlier "Test and Tune Clinics" and the recent "Vehicle Inspection Clinics", is that on-site mechanics no longer adjust (or tune) vehicle engine parameters and settings at the more recent clinics. This adjustment was curtailed because of potential liability problems; also, the adjustment mechanisms are not easily accessible on most new vehicles.

With a few exceptions, each vehicle brought for inspection was also subjected to an idle exhaust emissions test. Over the 13 clinics, 3 462 vehicles were presented, and emissions measurements and consistent data were obtained for approximately 3 200 of these vehicles. During the emissions test, the levels of total hydrocarbon (HC) and carbon monoxide (CO) were measured while the vehicle's engine was running in the idle mode. Vehicles were also visually examined for evidence of tampering and for lack of sufficient maintenance of their emissions control systems; valid data were recorded for 2 884 visual inspections.

By comparison, since the mid-1970s, the U.S. Environmental Protection Agency (EPA), has also obtained in-use vehicle data from annual vehicle inspections or "surveys". These surveys are performed by contract inspection teams in urban centres across the United States. For example, in 1989, the EPA teams inspected over 6 900 vehicles (U.S. EPA, 1989).

The Canadian clinic inspections and exhaust measurements were similar to those performed during the EPA surveys, except that gasoline fuel samples (analyzed for the presence of lead) were not taken at any of the Canadian clinics.

However, a major difference between the Canadian clinics and the EPA surveys was not the inspections, but rather the method of soliciting attendance. At most of the EPA surveys, a uniformed police officer directs motorists to the area where the vehicle is to be inspected. Attendance at all of the Canadian clinics was voluntary; motorists brought vehicles to an inspection clinic

because of media advertising or signs placed around the site.

When reviewing the data and the subsequent analysis presented in this report, it is important to note that the voluntary aspect of the inspection clinics may have introduced a bias, i.e., a purely random survey may have produced different data.

Another difference between the U.S. and Canadian tests is that the inspections at EPA surveys were performed by professional contractors and generally the same core personnel conducted each inspection. Except for clinics in Newfoundland (1989 and 1990), and Calgary and Edmonton (1986), the Canadian inspection clinics were operated by largely different personnel. For this reason, the data produced by the EPA teams are probably more consistent and reliable than the data generated by the Canadian inspection teams.

Despite the methodology, the information in this report represents the largest data set on tampering and idle emissions for the Canadian in-use vehicle fleet.

Section 3

Details

3.1 Location and Attendance

Since 1985, 13 vehicle inspection clinics have been held in Canada; over 3 400 vehicles were presented for inspection at these clinics (Table 1).

During Environment Week 1986, test clinics were conducted in seven Canadian cities, namely, St. John's, Halifax, Montreal, Winnipeg, Calgary, Edmonton, and Vancouver. Individual reports were written by Environment Canada regional staff on the Winnipeg, Vancouver, and Halifax clinics (Youmans, 1986; Poon, 1987; Environment Canada, 1986).

Table 1 Inspection Clinics (1986 to 1990)

Location	Date	Total Vehicles*	Inspections		
			Visual	Emissions	
				CO	HC
Montreal, Que.	3 to 5 Jun., '86	109	109	105	105
Winnipeg, Man.	2 to 5 Jun., '86	222	222	221	220
St. John's, Nfld.	2 to 6 Jun., '86	321	291	278	283
Halifax, N.S.	2 to 6 Jun., '86	248	248	237	245
Calgary, Alta.	5 to 7 Jun., '86	258	-	235	239
Edmonton, Alta.	1 to 3 Jun., '86	263	-	253	252
Vancouver, B.C.	2 to 5 Jun., '86	647	620	535	535
Brandon, Man.	23 to 27 Jun., '87	248	248	246	246
Saint John, N.B.	13 to 17 Jun., '88	196	196	193	192
St. John's, Nfld.	20 to 24 Jun., '89	297	297	297	297
Gander, Nfld.	11 to 12 Aug., '89	146	146	146	146
Dartmouth, N.S.	6 to 9 Jun., '90	231	231	231	231
St. John's, Nfld.	19 to 21 Jul., '90	276	276	275	275
	Total	3 462	2 884	3 252	3 266

* Only those vehicles with the model year recorded were considered as valid data for analysis. This exclusion may lead to different totals than those given in previous reports and references.

Note: There was some vehicle inspection activity in Toronto in June, 1986, but the sample was too small for comparison and therefore data from that area have not been included.

In 1987, a clinic was staged in Brandon, Manitoba (Youmans, 1988); in 1988, the clinic location was Saint John, New Brunswick. In 1989, clinics were held in two cities in Newfoundland: St. John's and Gander. In 1990, two more clinics were staged in maritime Canada: the first in Dartmouth, Nova Scotia; and the second in St. John's, Newfoundland.

3.2 Clinic Staff

The 1986 clinics were all conducted during the first week of June. The clinics in Calgary and Edmonton were conducted by the same crew, most of whom were provincial government employees. The clinics in St. John's, Montreal, and Winnipeg were conducted by different, locally organized teams of Environment Canada and provincial government employees. The Halifax and Vancouver clinics were contracted to local technical colleges, with assistance and supervision provided by Environment Canada regional personnel. The clinic in Montreal in 1986 and all subsequent clinics, have involved one or more staff members from Environment Canada's Transportation Systems Division and the Mobile Sources Emissions Division. At each test site, the staff assisted the provincial environment department and Environment Canada regional personnel.

3.3 Data Gathering

No standard format was used for data gathering during the seven clinics in 1986. Since then, however, an attempt has been made to standardize inspection procedures and data-gathering techniques at all inspection clinics (Cope, 1988b).

The Survey Form used for the clinic held in Dartmouth, Nova Scotia in June 1990 is discussed in detail in the Appendix. The numbers on this form correspond to those in a clinic database that was established using Dbase III+. The database was used to collate and analyze clinic data.

3.4 Style and Procedures

In general, all the clinics discussed in this report were held in large shopping mall parking lots. Vehicles were directed to the inspection area, and a team of three to five members checked each vehicle and recorded pertinent data.

The idle exhaust emissions were measured for each vehicle, following relatively standard procedures. These same procedures are used at most of the Inspection and Maintenance (I/M) clinics operating in the United States. Emissions were first measured at a fast idle of approximately 2 500 rpm; then the warm, or low idle speed was measured. Inspectors also performed a visual examination of underhood emissions control components. The catalytic converter and fuel inlet components were also inspected.

The inspection procedures and approximate clinic layout have been published (Cope, 1988b).

Section 4

Tampering Discussion

The following actions, or, in the case of maintenance, lack of action, are normally considered to be acts of tampering with vehicle emissions control systems:

- deliberate removal of an emissions control system component, e.g., the catalytic converter;
- deliberate disablement of an emissions control system, e.g., putting a ball bearing or a screw in one of the hose connections to the exhaust gas recirculation system (EGR) valve;
- loss of part of an emissions control system due to lack of maintenance, e.g., if the belt from an air pump system breaks and is not replaced;
- deterioration of components and system performance due to lack of preventive maintenance, e.g., a hole in the positive crankcase ventilation (PCV) hose;
- use of leaded fuel in a vehicle designated as "unleaded fuel only". Repeated misfuelling results in partial or total degradation of catalytic converter efficiency.

All these conditions or forms of tampering were noted during the visual inspections conducted at the clinics (Cope, 1988a).

Regardless of the action, the consequence of tampering is the same: emissions control systems on tampered vehicles are not limiting emissions to potential levels. Whether deliberate or as a result of negligence, tampering results in increased air emissions.

The systems inspected for tampering during the clinics include:

Control System	**Abbreviations**
Catalytic Converter	CAT
Oxidation Catalyst	Ox Cat, 2 Way, OC
Oxidation/Reduction Catalyst	3 Way, ORC
Fuel Inlet Components	
Fuel Inlet Restrictor	FIR
Fuel Cap	
Fuel Cap Seal	
"Unleaded Fuel Only" Tank Label	LBL
Air System	AIR
Air Pump and Belt	
Air Injection or Aspiration System	
Exhaust Gas Recirculation System	EGR
Evaporative Control System Cannister	EVAP
Positive Crankcase Ventilation System	PCV
Thermostatic Air Cleaner	TAC
Oxygen Sensor & Feedback System	O_2 Sensor
Carburetor Limit Caps or Seals	CAPS or SEALS

Note: Not all these checks were performed at all clinics and not all these components were checked on every vehicle.

Inspections were for visual deterioration or missing components. With the exception of the TAC stovepipe, systems were not dismantled and components were generally not handled by inspectors.

Also, with the exception of a dummy leaded fuel nozzle to check for the correct diameter of the fuel inlet restrictor, function tests were not performed.

Since the 1970s, most new vehicles equipped with a carburetor have been outfitted with either limit caps or seals that block access to adjustment screws. The installation of such devices was never required by federal regulation; however, vehicles are required to have emissions at or below the regulated standards throughout the range of the carburetor adjustments. To achieve the standards, manufacturers first used limiter caps and then seals to prevent casual adjustment of carburetor idle mixture screws.

However, for years it has been common practice to remove limit caps and seals in order to adjust carburetors. Although the condition of the limit caps or seals is frequently included in inspection reports, the dilemma of listing their removal as tampering is that even if they are missing, adjustments may still be within specification.

Since a simple idle test does not indicate compliance with federal emissions standards, such tampering was referred to by the U.S. EPA as "arguable tampering". In this report, where data exist, cap and seal tampering has been listed.

The tampering rates for the various components or systems are reported in the following sections. Note that the "Number Identified as Equipped" column in some of the tables refers to the number of vehicles for which an inspector was able to identify that a component was present, or that the vehicle was originally equipped with a component or system that was no longer present.

Identification was often difficult due to the inexperience of certain inspectors and the obscure location of some components. If the component could not be located, the inspector should have indicated this with a "?" or a blank on the form. Items were sometimes recorded as "not originally equipped" because the inspector could not find the device on the vehicle.

Note that, although an inspector looks for the presence and condition of a component during a tampering check, a visual inspection does not necessarily indicate the operating condition. For example, a visual inspection will only reveal that a catalytic converter is still installed on a vehicle and has not been bypassed or disabled; it does not reveal whether the converter is still operating correctly.

The tampering rates calculated and reported in the following sections refer to the percentage of visible tampering detected on vehicles where a positive component identification was made.

Section 5

Tampering Analysis

The results of the combined tampering analyses from the 11 clinics are presented in Table 2. (Note: Complete data from tampering inspections performed at the Calgary and Edmonton clinics were not available at time of publication.)

The 10% catalytic converter tampering rate is of particular interest. In comparison, the overall tampering rate for catalytic converters for the 6 991 vehicles inspected in 15 cities by the EPA in 1989 was 4%. However, a more direct comparison is the catalytic converter tampering rate in U.S. cities without a component Anti-Tampering Program (ATP). (Some of these cities may have had an I/M program that measured idle exhaust emission, but did not include the visual inspection of components.) The converter tampering rate in these cities was 7%. The Canadian catalytic converter tampering rate is 3% higher than areas in the U.S. without anti-tampering enforcement programs.

The U.S. data show how the implementation of an I/M program, which includes a visual tampering inspection, can influence tampering rates. The converter tampering rates in these areas dropped to 1%. Apparent reductions resulting from a tampering inspection and enforcement program are shown for all components checked.

The data in Table 3 indicate that, of the 2 884 vehicles that underwent a visual tampering inspection, 628 (or approximately 22%) had at least one emission control component that was damaged, removed, or disconnected. As with individual components, the tampering rate increases with vehicle age (Figure 1).

Multiple component tampering, i.e., one or more components tampered on the same vehicle, was found on 7 to 8% of the vehicles inspected. Tampering data on individual components are reported in the following sections.

5.1 Catalytic Converter

During the visual tampering checks, inspectors looked under vehicles for a catalytic converter. As mentioned in Section 4, a visual inspection of the catalytic converter will only reveal that the converter is still installed on the vehicle and has not been bypassed or disabled; it does not indicate whether the converter is still functioning.

The tampering rate for catalytic converters is shown in Table 4, both by clinic and by vehicle age. A graph of catalytic converter tampering rate in relation to vehicle age is shown in Figure 2; the tampering rate is typical of the pattern apparent in the annual EPA surveys. Little or no tampering occurs during the first four years of vehicle life (the normal warranty period), but tampering increases significantly from years five to 10. The erratic pattern of the tampering shown for the 11- to 13-year-old vehicles may be because fewer of these vehicles are available for inspection.

The tampering rates for the two clinics held in St. John's, Nfld. in 1989 and 1990 show a significant decline from the 1986 clinic in

Table 2 Overall Tampering Analysis Totals

Visible Tampering Pollution Control System	Canada - 1986 to 1990 (2 884 Vehicles)			EPA 1989 Survey (6 991 Vehicles)		
	Number Identified as Equipped	Visible Tampering		Tampering Rates		
				No ATP	ATP	Total
		No.	%	%	%	%
Catalytic Converter	1 916	188	10	7	1	4
Fuel Inlet Components						
Fuel Inlet Restrictor	2 155	117	5	6	2	5
Unleaded Tank Label	2 155	186	9			
Air Systems						
Pump and/or Belt	710	57	8	13	6	10
Injection System	220	5	2			
EGR Valve	2 265	109	5	7	3	6
Evaporative Emissions						
Cannister	2 476	50	2	6	4	6
PCV Systems	2 743	23	1	6	3	5
Thermostatic Air System - Total	2 584	204	8			
Stovepipe Disconnected	1 503	85	6			
Cleaner Inverted/Open	1 503	6	<1			
Arguable Tampering						
Carburetor Limit	958	450	47			
Caps & Seals						

Table 3 Tampered Vehicles vs Vehicle Age

Vehicle Age (Years)	Number Inspected	Number of Components Tampered 1	2	3	4	5	or >5	Total With at Least 1 Tampered Component	
								No.	%
0 to 1	137	3						3	2
1	356	18	1					19	5
2	376	25	1					26	7
3	324	24	7		1			32	10
4	327	36	8	3				47	14
5	337	61	13	3			2	79	23
6	234	47	17	8	3	1		76	33
7	182	50	18	8	1	1	1	79	43
8	164	39	19	6	4	1		69	42
9	114	30	19	12	1	2	1	65	57
10	86	23	10	7	4	1	1	46	54
11	61	13	9	2	1	1	1	27	44
12	48	16	5	1				22	46
13 and older	138	27	9	2				38	28
Total No.	2 884	412	136	52	15	7	6	628	
%		15	5	2	<1	<1	<1		22

the same city. Although there was no anti-tampering enforcement during the interval, anti-tampering legislation had been introduced.

Similarly, although there is no anti-tampering legislation for Nova Scotia, the tampering rate dropped significantly from 15% in 1986 to 7% in 1990. This reduction in converter tampering could be due to increased environmental awareness both within the general public and the vehicle service industry.

High catalytic converter tampering rates were noted for the prairie cities of Winnipeg and Brandon.

Although the converter tampering rate was inexplicably low for the B.C. clinic in 1986, the idle exhaust emissions for that clinic were relatively high and there was a high

Table 4 Catalytic Converter Tampering

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	119	0	0
1	356	277	7	3
2	376	289	4	1
3	324	238	4	2
4	327	222	8	4
5	337	244	26	11
6	234	163	25	15
7	182	122	32	26
8	164	104	29	28
9	114	62	33	53
10	86	47	14	30
11	61	20	3	15
12	48	5	2	40
13 and older	138	4	1	25
	2 884	1 916	188	10

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	69	9	13
Winnipeg	1986	WPG86	222	142	19	13
St. John's	1986	NF86	291	210	34	16
Halifax	1986	NS86	248	102	15	15
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	323	8	2
Brandon	1987	BRA87	248	176	28	16
Saint John	1988	NB88	196	154	12	8
St. John's	1989	ND89	297	237	22	9
Gander	1989	GR89	146	115	13	11
Dartmouth	1990	DA90	231	182	13	7
St. John's	1990	ST90	276	206	15	7
			2 884	1 916	188	10

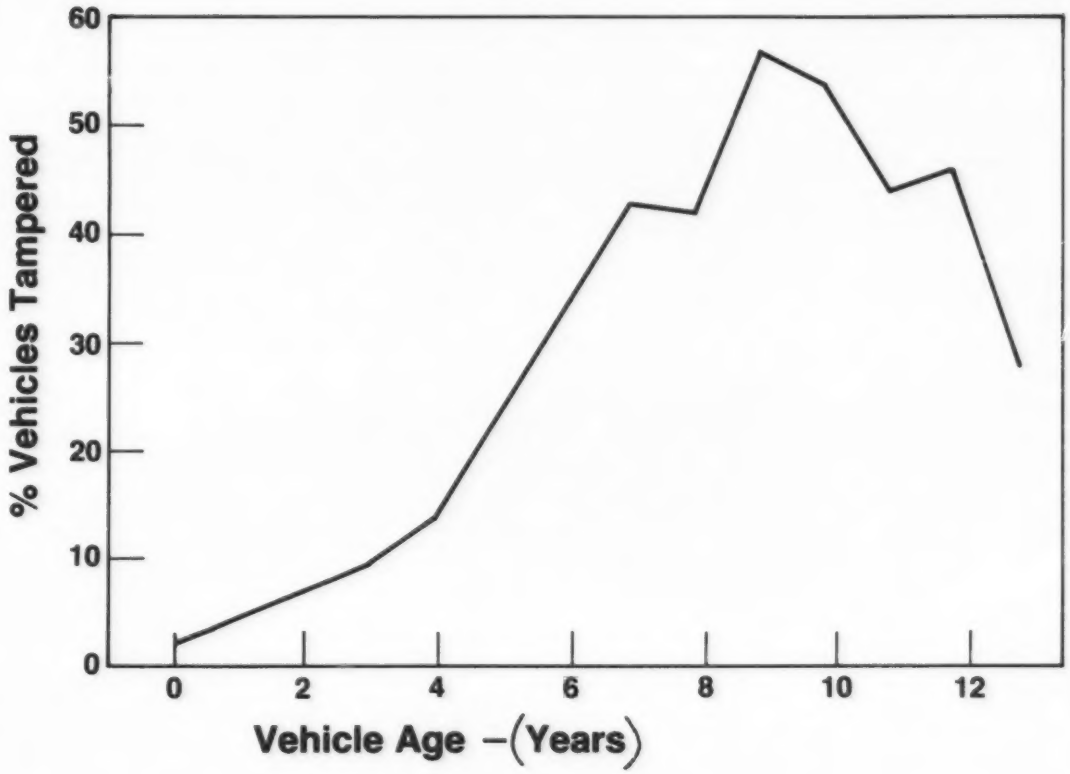

Figure 1 Vehicles with at Least One Component Tampered

percentage of emissions failures. The tampering rates for both the Fuel Inlet Restrictor and the Unleaded Fuel Only Tank Label were also above average for the Vancouver clinic. These findings indicate a high incidence of misfuelling and resulting damage to the catalytic converter, or even the removal of the converter.

5.2 Fuel Inlet Components - General

The inspection of the Fuel Inlet Restrictor (FIR) and the Unleaded Fuel Only Tank Label (LBL) relates directly to the problem of misfuelling an "unleaded fuel only" vehicle with leaded fuel. A damaged or missing inlet restrictor is a reasonable indication that the vehicle was misfuelled at some time and the conversion efficiency of the converter has most likely been permanently damaged.

A painted-over or missing tank label could either mean nothing or it could indicate a deliberate attempt to disguise the fact that a vehicle was originally designated for unleaded fuel only.

Since unleaded fuel was virtually eliminated in Canada in December 1990, these two components now have little or no function, but evidence of tampering still indicates that an older vehicle's catalytic converter may be damaged. It is interesting to note that in several I/M programs in the United States, if a Fuel Inlet Restrictor is missing or damaged, the vehicle owner is required to

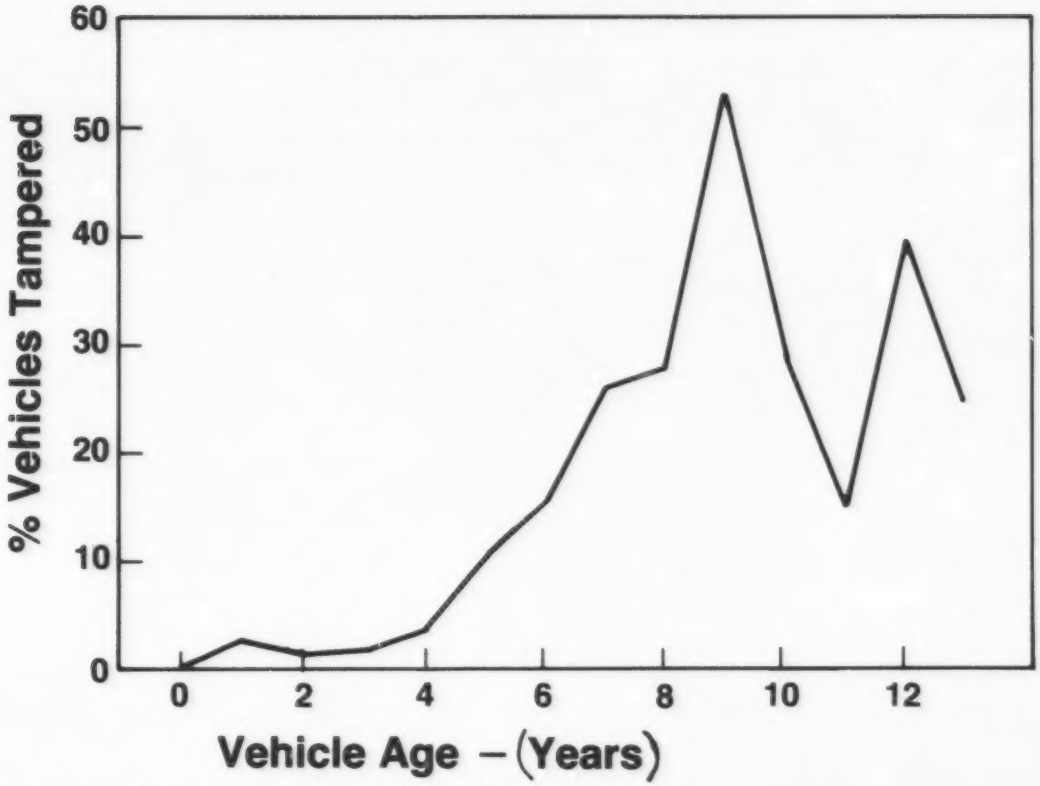

Figure 2 Catalytic Converter Tampering Rate

replace the catalytic converter and a cost waiver is not allowed.

5.2.1 Fuel Inlet Restrictor (FIR)

The FIR tampering rates related to both vehicle age and clinic location are shown in Table 5. As for the catalytic converter (and most other emissions components), tampering of the FIR increases with vehicle age.

In most cases, FIR tampering is significantly lower in clinics held since 1988. This is a direct reflection of reduced availability of leaded gasoline and increased public awareness of the adverse environmental effect of lead.

A tampering rate of 12% was recorded in Brandon in 1987. This appears to confirm the earlier results that revealed a high incidence of misfuelling in the prairie provinces.

5.2.2 Unleaded Fuel Only Tank Label (LBL)

The removal of a tank label from a vehicle or the obscuring of such a label with paint is not an indication that a vehicle has been misfuelled. However, it could mean that misfuelling has taken place and the converter is damaged.

The fact that the incidence of missing labels increases with vehicle age is shown in Table 6. This is not unexpected since many vehicles that are six or more years old have been partially or totally repainted.

Table 5 FIR - Fuel Inlet Restrictor Tampering

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	124	1	1
1	356	306	1	0
2	376	314	1	0
3	324	271	6	2
4	327	261	4	2
5	337	271	16	6
6	234	187	14	7
7	182	140	14	10
8	164	121	15	12
9	114	72	21	29
10	86	54	11	20
11	61	26	9	35
12	48	4	1	25
13 and older	138	4	3	75
	2 884	2 155	117	5

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	74	6	8
Winnipeg	1986	WPG86	222	147	11	7
St. John's	1986	NF86	291	220	6	3
Halifax	1986	NS86	248	174	16	9
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	367	31	8
Brandon	1987	BRA87	248	187	23	12
Saint John	1988	NB88	196	172	8	5
St. John's	1989	ND89	297	259	11	4
Gander	1989	GR89	146	131	2	2
Dartmouth	1990	DA90	231	195	2	1
St. John's	1990	ST90	276	229	1	<1
			2 884	2 155	117	5

Table 6 "Unleaded Fuel Only" Tank Label Tampering

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	125	1	1
1	356	303	6	2
2	376	315	13	4
3	324	273	13	5
4	327	262	12	5
5	337	269	21	8
6	234	185	24	13
7	182	142	27	19
8	164	121	21	17
9	114	72	17	24
10	86	54	20	37
11	61	25	7	28
12	48	5	2	40
13 and older	138	4	2	50
	2 884	2 155	186	9

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	74	11	15
Winnipeg	1986	WPG86	222	146	10	7
St. John's	1986	NF86	291	221	17	8
Halifax	1986	NS86	248	180	26	14
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	369	45	12
Brandon	1987	BRA87	248	187	13	7
Saint John	1988	NB88	196	173	15	9
St. John's	1989	ND89	297	248	21	8
Gander	1989	GR89	146	132	5	4
Dartmouth	1990	DA90	231	195	7	4
St. John's	1990	ST90	276	230	16	7
			2 884	2 155	186	9

5.2.3 *Fuel Cap and Seal*

The fuel caps and seals were checked on most vehicles and little tampering was found (below 1%).

When it did occur, however, the tampering was usually in the form of a missing fuel cap. These vehicles will have high evaporative emissions, particularly during hot summer months.

5.2.4 *Tailpipe Lead Test*

Lead-sensitive paper, Plumbtesmo, was used at clinics from 1987 to 1990. Motorists were asked what type of gasoline they normally used, their FIR and Tank Label were checked, and a Plumbtesmo test was performed on certain vehicles.

A piece of Plumbtesmo paper is placed in a vehicle's tailpipe and a red colour change indicates a detectable level of lead in the deposit that coats the pipe. In general, only vehicles designated as "unleaded fuel only" were tested, although some leaded fuel vehicles that had been fuelled with unleaded gasoline were also tested.

The number of positive lead test indications was very low, indicating that few of the vehicles were misfuelled at or around the time of the inspections.

5.3 *Air Injection/Aspiration - Air Pump and Belt*

Approximately one third of the vehicles inspected were identified as being originally equipped with a supplementary air system. Of the 2 884 vehicles inspected, 710 were recorded as being originally equipped with air pumps, and 220 were equipped with some form of air system that did not employ a pump (Table 7).

There was little tampering detected with the non-pump systems: approximately 2%. During a quick visual inspection when components are not handled, it is difficult to detect leaks or similar faults with non-pump systems. Deliberate tampering with such systems involves reasonably complex hardware disablement, particularly when compared to pump systems where missing belts were the most common fault.

Tampering is highest on older vehicles, and in 1986 tampering rates for pump systems varied from none in Montreal to 15% in Winnipeg. Most of the tampering with pump systems takes the form of a missing belt; in many cases, the belt snaps after the air pump seizes. Other incidents involve removal of the air pump and the associated plumbing.

The average tampering rate for the 710 vehicles equipped with pumps was 8%, although rates of 10% were recorded at three of the four most recent clinics.

5.4 *Exhaust Gas Recirculation (EGR) Systems*

As with other systems, tampering with the EGR systems increases with vehicle age, although not to the high levels recorded with certain other components (Table 8).

The overall tampering rate for the 2 265 vehicles equipped with an EGR system was 5%. At two clinics in 1986, EGR tampering rates of 12 and 13% were detected.

EGR function was not tested. The hoses attached to the EGR valve were checked for blockage due to foreign objects, such as ball-bearings. If the hoses were clear, the EGR valve was reported to be still on the vehicle, with all associated hoses still attached.

Table 7 Tampering - Air Pumps, Belts and Systems

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	23		0
1	356	97	2	2
2	376	108		0
3	324	79	2	3
4	327	82	2	2
5	337	75	5	7
6	234	89	8	9
7	182	38	7	18
8	164	37	5	14
9	114	28	10	36
10	86	23	6	26
11	61	17	6	35
12	48	4	1	25
13 and older	138	10	3	30
Air Pumps and Belts	2 884	710	57	8

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
			A	B	B/A	
Montreal	1986	MTL86	109	21	0	0
Winnipeg	1986	WPG86	222	62	9	15
St. John's	1986	NF86	291	57	3	5
Halifax	1986	NS86	248	107	3	3
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	137	11	8
Brandon	1987	BRA87	248	80	10	13
Saint John	1988	NB88	196	52	3	6
St. John's	1989	ND89	297	71	7	10
Gander	1989	GR89	146	36	4	11
Dartmouth	1990	DA90	231	39	4	10
St. John's	1990	ST90	276	48	3	6
Pumps and Belts			2 884	710	57	8
Injection Systems			2 884	220	5	2

Table 8 EGR System Tampering

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	95	0	0
1	356	285	2	1
2	376	323	3	1
3	324	274	3	1
4	327	268	8	3
5	337	286	12	4
6	234	187	19	10
7	182	154	9	6
8	164	128	9	7
9	114	91	11	12
10	86	67	12	18
11	61	46	7	15
12	48	30	8	27
13 and older	138	31	6	19
	2 884	2 265	109	5

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	85	11	13
Winnipeg	1986	WPG86	222	182	9	5
St. John's	1986	NF86	291	224	26	12
Halifax	1986	NS86	248	209	9	4
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	450	23	5
Brandon	1987	BRA87	248	207	9	4
Saint John	1988	NB88	196	173	7	4
St. John's	1989	ND89	297	247	2	1
Gander	1989	GR89	146	125	2	2
Dartmouth	1990	DA90	231	162	6	4
St. John's	1990	ST90	276	201	5	2
			2 884	2 265	109	5

Although the entire EGR valve was missing on a few vehicles, a disconnected hose was the most common form of tampering.

5.5 *Evaporative Control System Cannister (EVAP)*

This form of tampering relates entirely to the evaporative emissions cannister and associated hoses. The fuel cap and seal are evaporative emissions control system components, but little tampering with these devices was noted (refer to Subsection 5.2.3).

There was little evidence of tampering with the evaporative cannister on the 2 476 vehicles that were identified as originally equipped. The average for all clinics was 2%, with a tampering rate of 4% detected in Vancouver in 1986 (Table 9).

The most common form of tampering with the evaporative cannister is the removal or severing of a connecting hose.

5.6 *Positive Crankcase Ventilation (PCV) System*

The overall tampering rate for the PCV systems was approximately 1% on the 2 743 vehicles that were identified as originally equipped. At three clinics, no obvious tampering with this device was noted. The highest rate was recorded in Brandon in 1987 where 3% of the vehicles had tampered PCV valves (Table 10).

Note that like the EGR system testing methodology, no function testing of PCV valves was attempted.

5.7 *Thermostatic Air Cleaner (TAC)*

The forms of tampering found during visual inspections of the thermostatic air cleaner and associated hardware included:

- dislocation, deterioration, or loss of the heated air "stovepipe" which connects a manifold on the engine block to the air cleaner;
- inversion of the top or lid of the air cleaner;
- replacement of the original equipment air cleaner with an aftermarket variety with an open, no-side design;
- missing air cleaners.

The frequent dislocation problems associated with the stovepipe portion of the thermostatic air cleaner appear to result from neglect or insufficient maintenance. The stovepipes deteriorate with time, and the end fittings work loose and eventually one or both ends become disconnected.

If the stovepipe was disconnected from its fittings, an inspector usually reconnected the device and informed the vehicle driver that it should be inspected frequently, particularly during cold weather.

Other problems related to insufficient maintenance include numerous holes in the fabric of a stovepipe or a badly deteriorated or missing heat manifold. Inverted air cleaner lids indicated deliberate tampering.

For the 2 584 vehicles identified as originally equipped with some form of TAC, the overall tampering rate was 8% (Table 11). Because of the nature of stovepipe displacement tampering, some cases of this form of tampering were noted

Table 9 EVAP System Tampering

Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
			No.	%
		A	B	B/A
0 to 1	137	120		0
1	356	321		0
2	376	335	1	0
3	324	298	2	1
4	327	283	2	1
5	337	313	2	1
6	234	205	3	1
7	182	161	7	4
8	164	136	6	4
9	114	96	8	8
10	86	75	10	13
11	61	47	4	9
12	48	36	2	6
13 and older	138	50	3	6
	2 884	2 476	50	2

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	100	2	2
Winnipeg	1986	WPG86	222	189	5	3
St. John's	1986	NF86	291	228	5	2
Halifax	1986	NS86	248	226	3	1
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	485	17	4
Brandon	1987	BRA87	248	216	6	3
Saint John	1988	NB88	196	179	1	1
St. John's	1989	ND89	297	266	0	0
Gander	1989	GR89	146	136	3	2
Dartmouth	1990	DA90	231	200	2	1
St. John's	1990	ST90	276	251	6	2
			2 884	2 476	50	2

Table 10 PCV System Tampering

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	104	0	0
Winnipeg	1986	WPG86	222	206	4	2
St. John's	1986	NF86	291	253	3	1
Halifax	1986	NS86	248	241	0	0
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	586	2	<1
Brandon	1987	BRA87	248	236	6	3
Saint John	1988	NB88	196	191	0	0
St. John's	1989	ND89	297	292	3	1
Gander	1989	GR89	146	143	1	1
Dartmouth	1990	DA90	231	222	2	1
St. John's	1990	ST90	276	269	2	1
			2 884	2 743	23	1

for nearly new vehicles: 6% had misplaced or missing stovepipes.

Open, non-stock air cleaners, no air cleaner, or air cleaner inversion were identified on less than 1% of the vehicles.

5.8 Oxygen Sensor (O_2)

Although not checked at all clinics, the oxygen sensor (O_2), and its immediate electrical connection were visually located on most vehicles inspected since 1987. There were only one or two recorded instances of a broken electrical connection to an O_2 sensor.

However, a larger number of relatively new vehicles equipped with oxygen sensors (complete with intact emissions control equipment), had very high idle emissions of CO and HC. The O_2 sensors on these vehicles appeared to be physically intact. The high emissions could result from a computer control malfunction, either from an internal electronic problem or a fouled oxygen sensor. Neither of these conditions is detectable during a visual inspection.

Table 11 TAC Tampering

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	100	8	8
Winnipeg	1986	WPG86	222	204	10	5
St. John's	1986	NF86	291	252	31	12
Halifax	1986	NS86	248	198	11	6
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	534	38	7
Brandon	1987	BRA87	248	240	11	5
Saint John	1988	NB88	196	194	15	8
St. John's	1989	ND89	297	293	24	8
Gander	1989	GR89	146	142	11	8
Dartmouth	1990	DA90	231	203	17	8
St. John's	1990	ST90	276	224	28	13
			2 884	2 584	204	8
Stovepipe Disconnected			1 503	1 396	85	6
Cleaner Inverted or Open			1 503	1 396	6	<1

Section 6

Arguable Tampering - Carburetor Caps or Seals

The removal of carburetor adjustment limit caps or seals allows full access to the adjusting screws. These caps or seals were originally put in place either to limit or prevent adjustment of these screws. Although limit caps are easy to remove, most carburetor seals cannot be removed unless the entire carburetor is taken out.

The U.S. EPA has labelled this form of tampering "arguable", because although the removal is deliberate, a missing seal or cap is not necessarily an indication that adjustments are not to specification.

The arguable tampering rates for the clinics are shown in Table 12. Except for a low of 26% at the 1989 clinic in Gander, Newfoundland, rates range from 40 to 55% removal with an average for all clinics of just under 50%.

Table 12 Arguable Tampering - Carburetor Caps or Seals

1987 Brandon Only	Vehicle Age (Years)	Number Inspected	Number Identified as Equipped	Visible Tampering	
				No.	%
			A	B	B/A
	0 to 1	11	4	1	25
	1	22	12	2	17
	2	35	24	6	25
	3	28	20	3	15
	4	20	17	9	53
	5	24	18	7	39
	6	21	17	11	65
	7	17	15	8	53
	8	13	11	9	82
	9	13	13	12	92
	10	10	9	9	100
	11	11	7	7	100
	12	5	5	4	80
	13 and older	18	11	10	91
		248	183	98	54

City	Year	Clinic Code	Number Inspected	Number Identified as Equipped	Visible Tampering	
					No.	%
				A	B	B/A
Montreal	1986	MTL86	109	85	46	54
Winnipeg	1986	WPG86	222	128	64	50
St. John's	1986	NF86	No Inspection This Component			
Halifax	1986	NS86	No Inspection This Component			
Calgary	1986	CAL86	Complete Tampering Data Unavailable			
Edmonton	1986	EDM86	Complete Tampering Data Unavailable			
Vancouver	1986	BC86	620	240	105	44
Brandon	1987	BRA87	248	183	98	54
Saint John	1988	NB88	196	109	53	49
St. John's	1989	ND89	297	119	49	41
Gander	1989	GR89	146	46	12	26
Dartmouth	1990	DA90	231	48	23	48
St. John's	1990	ST90	No Inspection This Component			
			2 069	958	450	47

Section 7

Idle Emissions

Most of the vehicles brought for inspection were subjected to an emissions test at two different idle speeds - a warm, low, or curb idle speed (usually 700 to 1 200 rpm) and a higher one of approximately 2 500 rpm. Although exhaust emissions were measured at the higher rpm, this test mode primarily allowed a period of engine preconditioning for vehicles that may have been parked for several hours before inspection. Only the low idle measurement results and vehicles with consistent results at both high and low idle speeds are listed. The procedures for measuring idle emissions were relatively standard and similar to those used by most Inspection and Maintenance programs in the United States.

For most clinics, the exhaust emissions were measured using an EPA 75 two-gas (HC and CO) analyzer. Although they are dated, the instruments used at the 1986 clinic in Montreal and all subsequent clinics were upgraded, serviced, and well maintained by the staff of the Environment Canada Mobile Sources Emissions Division (MSED) in Ottawa. Also, at most clinics, a cylinder of certified calibration gas was used to perform daily (or more frequent) span checks. At all of the clinics using the MSED analyzers, at least two analyzers were used, with the backup machine being substituted if problems developed with the first analyzer.

In the general test procedure, a probe was inserted into the vehicle exhaust, and an induction tachometer was connected to a spark plug wire. The engine rpm was then raised to 2 500 for approximately 30 seconds or until steady readings were recorded. The engine rpm was then lowered and allowed to stabilize. Warm idle emissions levels of total hydrocarbons (HC) and carbon monoxide (CO) were then recorded.

The exhaust emissions test limits or pass/fail levels used for evaluating emissions measurements at each clinic are shown in Table 13. For vehicles of model year 1987 and older, the limits follow a simple progression of an added 0.1% per year for CO and an additional 30 ppm for HC. These limits are equal to or less strict than those used for pass/fail criteria at I/M programs in the United States. Therefore, vehicles with emissions greater than the clinic limits would have failed most I/M inspections.

The U.S. EPA recommends low idle test levels of 1.2% CO and 220 ppm HC for 1981 and newer "U.S. 49-state specification vehicles". Since many Canadian vehicles of model years 1981 to 1987 were equipped with older technology emissions control systems, much more lenient pass/fail limits for the clinic data were used. However, all 1988 and newer model year vehicles were subjected to the EPA limits (Table 13).

The emissions levels used to analyze this clinic data were reasonably lax and any untampered vehicle in a reasonable state of repair should have emissions at or below the listed maximums.

7.1 Measurement Results

The number of vehicles at each of the 13 clinics with emissions below the maximum limits for CO and HC (Table 13)

are listed in Tables 14 and 15. Three additional columns have been added to the tables to show the number of vehicles at each clinic with emissions at 1 to 2, 2 to 3, or greater than 3 times the maximum limits. The measurement results have been presented both as a function of vehicle age and by clinic.

The clinic results indicate that approximately 25% of the vehicles tested had emissions greater than the maximum limit of CO and 15% greater than the limit of HC. From an "excess" emissions point of view, what is more disturbing is to discover that six vehicles that were only one year old had CO emissions greater than three times these very lax emissions limits. For HC emissions, two one-year-old vehicles had emissions greater than three times the limit.

At each clinic, two or three vehicles were presented for inspection with CO and/or HC emissions that drove the analyzers off scale at 10% CO or 2 000 ppm HC.

The credibility of the idle emissions test as a tool for accurately measuring vehicle emissions and for comparing those idle concentration measurements to the federally mandated mass emissions standards has frequently been questioned. Vehicles that put a well-maintained and calibrated analyzer off-scale or with measured idle emissions greater than twice these very lax standards, however, are truly "gross emitters" of HC and CO.

Table 13 Clinic Test Limits

Model Year		2 500 rpm				Low Idle rpm			
		>4 cyl		4 cyl		>4 cyl		4 cyl	
		CO %	HC ppm	CO %	HC ppm	CO %	HC ppm	CO %	HC ppm
*	**								
	1990	1.0	200	1.0	200	1.2	220	1.2	220
	1989	1.0	200	1.0	200	1.2	220	1.2	220
	1988	1.0	200	1.0	200	1.2	220	1.2	220
1986	1987	1.0	200	1.5	200	1.5	300	2.5	300
1985	1986	1.1	230	1.6	230	1.6	330	2.6	330
1984	1985	1.2	260	1.7	260	1.7	360	2.7	360
1983	1984	1.3	290	1.8	290	1.8	390	2.8	390
1982	1983	1.4	320	1.9	320	1.9	420	2.9	420
1981	1982	1.5	350	2.0	350	2.0	450	3.0	450
1980	1981	1.6	380	2.1	380	2.1	480	3.1	480
1979	1980	1.7	410	2.2	410	2.2	510	3.2	510
1978	1979	1.8	440	2.3	440	2.3	540	3.3	540
1977	1978	1.9	470	2.4	470	2.4	570	3.4	570
1976	1977	2.0	500	2.5	500	2.5	600	3.5	600
1975	1976	2.1	530	2.6	530	2.6	630	3.6	630
1974	1975	2.2	560	2.7	560	2.7	660	3.7	660
1973	1974	2.3	590	2.8	590	2.8	690	3.8	690

* used for all 1986 clinics
** used for 1987 and more recent clinics

Table 14 Carbon Monoxide Emissions (Low Idle Exhaust Measurements Compared to Test Limits)

Vehicle Age (Years)	Number Tested	Less than limit		1 to 2 times limit		2 to 3 times limit		>3 times limit	
		No.	%	No.	%	No.	%	No.	%
0 to 1	141	136	96.5	4	2.8	1	0.7	0	0.0
1	368	338	91.8	18	4.9	6	1.6	6	1.6
2	398	353	88.7	22	5.5	17	4.3	6	1.5
3	349	299	85.7	27	7.7	13	3.7	10	2.9
4	371	295	79.5	46	12.4	12	3.2	18	4.9
5	380	296	77.9	43	11.3	28	7.4	13	3.4
6	282	213	75.5	30	10.6	21	7.4	18	6.4
7	231	149	64.5	41	17.7	27	11.7	14	6.1
8	191	116	60.7	37	19.4	26	13.6	12	6.3
9	144	77	53.5	41	28.5	19	13.2	7	4.9
10	108	65	60.2	22	20.4	12	11.1	9	8.3
11	75	41	54.7	19	25.3	11	14.7	4	5.3
12	54	31	57.4	11	20.4	8	14.8	4	7.4
13 and older	160	75	46.9	54	33.8	23	14.4	8	5.0
	3 252	2 484	76.4	415	12.8	224	6.9	129	4.0

Year	Clinic Code	Number Tested	Less than limit		1 to 2 times limit		2 to 3 times limit		>3 times limit	
			No.	%	No.	%	No.	%	No.	%
1986	MTL86	105	75	71.4	12	11.4	16	15.2	2	1.9
1986	WPG86	221	144	65.2	43	19.5	27	12.2	7	3.2
1986	NF86	278	222	79.9	25	9.0	21	7.6	10	3.6
1986	NS86	237	192	81.0	23	9.7	5	2.1	17	7.2
1986	CAL86	235	143	60.9	38	16.2	27	11.5	27	11.5
1986	EDM86	253	160	63.2	50	19.8	20	7.9	23	9.1
1986	BC86	535	409	76.4	78	14.6	37	6.9	11	2.1
1987	BRA87	246	186	75.6	35	14.2	24	9.8	1	0.4
1988	NB88	193	149	77.2	22	11.4	9	4.7	13	6.7
1989	ND89	297	253	85.2	25	8.4	13	4.4	6	2.0
1989	GR89	146	121	82.9	20	13.7	4	2.7	1	0.7
1990	DA90	231	195	84.4	19	8.2	12	5.2	5	2.2
1990	ST90	275	235	85.5	25	9.1	9	3.3	6	2.2
		3 252	2 484	76.4	415	12.8	224	6.9	129	4.0

Table 15 Hydrocarbon Emissions (Low Idle Exhaust Measurements Compared to Test Limits)

Vehicle Age (Years)	Number Tested	Less than limit		1 to 2 times limit		2 to 3 times limit		>3 times limit	
		No.	%	No.	%	No.	%	No.	%
0 to 1	142	132	93.0	10	7.0	0	0.0	0	0.0
1	371	334	90.0	30	8.1	5	1.3	2	0.5
2	403	356	88.3	37	9.2	7	1.7	3	0.7
3	350	302	86.3	41	11.7	3	0.9	4	1.1
4	372	298	80.1	53	14.2	12	3.2	9	2.4
5	380	316	83.2	47	12.4	9	2.4	8	2.1
6	285	237	83.2	37	13.0	6	2.1	5	1.8
7	232	193	83.2	35	15.1	3	1.3	1	0.4
8	192	163	84.9	24	12.5	4	2.1	1	0.5
9	143	116	81.1	20	14.0	2	1.4	5	3.5
10	108	84	77.8	18	16.7	4	3.7	2	1.9
11	76	60	78.9	12	15.8	1	1.3	3	3.9
12	53	45	84.9	5	9.4	1	1.9	2	3.8
13 and older	159	130	81.8	18	11.3	4	2.5	7	4.4
	3 266	2 766	84.7	387	11.8	61	1.9	52	1.6

Year	Clinic Code	Number Tested	Less than limit		1 to 2 times limit		2 to 3 times limit		>3 times limit	
			No.	%	No.	%	No.	%	No.	%
1986	MTL86	105	86	81.9	15	14.3	2	1.9	2	1.9
1986	WPG86	220	186	84.5	26	11.8	5	2.3	3	1.4
1986	NF86	283	253	89.4	23	8.1	5	1.8	2	0.7
1986	NS86	245	230	93.9	12	4.9	1	0.4	2	0.8
1986	CAL86	239	193	80.8	37	15.5	4	1.7	5	2.1
1986	EDM86	252	200	79.4	38	15.1	10	4.0	4	1.6
1986	BC86	535	478	89.3	44	8.2	5	0.9	8	1.5
1987	BRA87	246	211	85.8	26	10.6	6	2.4	3	1.2
1988	NB88	192	159	82.8	26	13.5	6	3.1	1	0.5
1989	ND89	297	264	88.9	25	8.4	2	0.7	6	2.0
1989	GR89	146	126	86.3	17	11.6	3	2.1	0	0.0
1990	DA90	231	180	77.9	46	19.9	3	1.3	2	0.9
1990	ST90	275	200	72.7	52	18.9	9	3.3	14	5.1
		3 266	2 766	84.7	387	11.8	61	1.9	52	1.6

Section 8

Discussion

The tampering inspection data from the 13 clinics (conducted from 1986 to 1990) indicate that over 20% of the vehicles had at least one emissions control system component with some form of visible evidence of deliberate tampering or deterioration due to insufficient maintenance. This does not include possible misadjusted carburetor settings in the "arguable tampering" category.

Tampering varied from the simple displacement of an air cleaner stovepipe to the removal of a catalytic converter; in extreme cases, tampering led to the removal or destruction of virtually every emissions control system on a vehicle. Individual component tampering rates included 10% for catalytic converters, 8% for air pumps, and 5% for EGR systems.

In conjunction with high tampering rates were the idle emissions measurement data from 13 clinics. The data showed that, of the vehicles tested, approximately 25% violated a reasonably lax CO emissions limit and 15% were above the HC limit. If these were the pass/fail cutpoints in an I/M style enforcement program, any vehicle failing at either the HC or CO limit would not be issued a renewed vehicle permit until some repairs were performed to reduce these emission levels.

It is recognized that an idle test can capture or identify what are referred to as "gross emitters". At the clinics, 129 vehicles had CO emissions at least three times greater than acceptable levels, and 52 vehicles had HC emissions at least three times higher.

Although classed only as "arguable tampering" by the EPA, an overall rate of carburetor limit cap or seal removal of approximately 50% could account for the relatively high number of "gross emitters" identified at these clinics.

A detailed analysis and report of each clinic is beyond the scope of this report; however, Table 16 compares the results for clinics held in Dartmouth, Nova Scotia and St. John's, Newfoundland in 1986, to a clinic in St. John's held in 1989. The lower tampering rates shown in the 1989 clinic likely result from a combination of the anti-tampering legislation introduced by the province of Newfoundland, the increased public awareness of environmental issues, and the development of vehicles with more complex, less-easily-tampered emissions technology.

The 1989 overall tampering rate from the U.S. EPA survey is compared to the rate from the clinic held in St. John's in 1989 in Figure 3. The graph shows that like the EPA data, the overall rate of tampering with emissions control components increases with vehicle age. The data also appear to indicate a tampering rate higher than the rate in the U.S. for this particular sample of the Canadian in-use vehicle fleet.

Table 16 Tampering Rates at Three Inspection Clinics

Pollution Control System	Number Equipped		Visible Tampering	
	No.	%	No.	%
Dartmouth, Nova Scotia, 1986 248 Vehicles Inspected				
Thermostatic Air Cleaner	198	80	11	6
Catalytic Converter	102	41	15	15
Fuel Inlet Restrictor	174	70	16	9
Unleaded Fuel Tank Label	180	73	26	14
Air Pump or Injection System	124	50	5	4
EGR Valve	209	84	9	4
Evaporative Emissions System	226	91	3	1
PCV System	241	97	0	0
St. John's, Newfoundland, June 1986 291 Vehicles Inspected				
Thermostatic Air Cleaner	252	87	31	12
Catalytic Converter	210	72	34	16
Fuel Inlet Restrictor	220	76	6	3
Unleaded Fuel Tank Label	221	76	17	8
Air Pump or Injection System	60	21	3	5
EGR Valve	224	77	26	12
Evaporative Emissions System	228	78	5	2
PCV System	253	87	3	1
St. John's, Newfoundland, June 1989 297 Vehicles Inspected				
Thermostatic Air Cleaner	293	97	24	8
Stovepipe Disconnect	293	97	19	6
Catalytic Converter	237	80	22	9
Fuel Inlet Restrictor	259	87	11	4
Unleaded Fuel Tank Label	248	84	21	8
Air Pump	71	24	3	4
Air Pump Belt	71	24	7	10
Air Injection System	23	8	0	0
EGR Valve	247	83	2	1
Evaporative Emissions System	266	90	0	0
PCV System	292	98	3	1

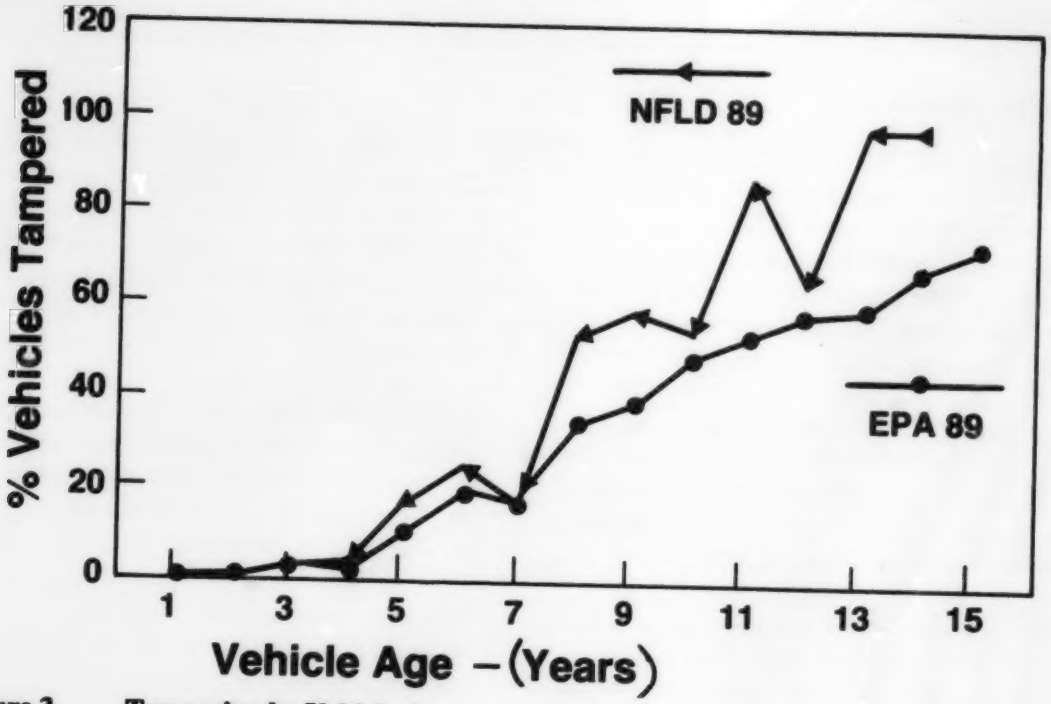

Figure 3 **Tampering by Vehicle Age**

Table 16 Tampering Rates at Three Inspection Clinics

Pollution Control System	Number Equipped		Visible Tampering	
	No.	%	No.	%
Dartmouth, Nova Scotia, 1986 248 Vehicles Inspected				
Thermostatic Air Cleaner	198	80	11	6
Catalytic Converter	102	41	15	15
Fuel Inlet Restrictor	174	70	16	9
Unleaded Fuel Tank Label	180	73	26	14
Air Pump or Injection System	124	50	5	4
EGR Valve	209	84	9	4
Evaporative Emissions System	226	91	3	1
PCV System	241	97	0	0
St. John's, Newfoundland, June 1986 291 Vehicles Inspected				
Thermostatic Air Cleaner	252	87	31	12
Catalytic Converter	210	72	34	16
Fuel Inlet Restrictor	220	76	6	3
Unleaded Fuel Tank Label	221	76	17	8
Air Pump or Injection System	60	21	3	5
EGR Valve	224	77	26	12
Evaporative Emissions System	228	78	5	2
PCV System	253	87	3	1
St. John's, Newfoundland, June 1989 297 Vehicles Inspected				
Thermostatic Air Cleaner	293	97	24	8
Stovepipe Disconnect	293	97	19	6
Catalytic Converter	237	80	22	9
Fuel Inlet Restrictor	259	87	11	4
Unleaded Fuel Tank Label	248	84	21	8
Air Pump	71	24	3	4
Air Pump Belt	71	24	7	10
Air Injection System	23	8	0	0
EGR Valve	247	83	2	1
Evaporative Emissions System	266	90	0	0
PCV System	292	98	3	1

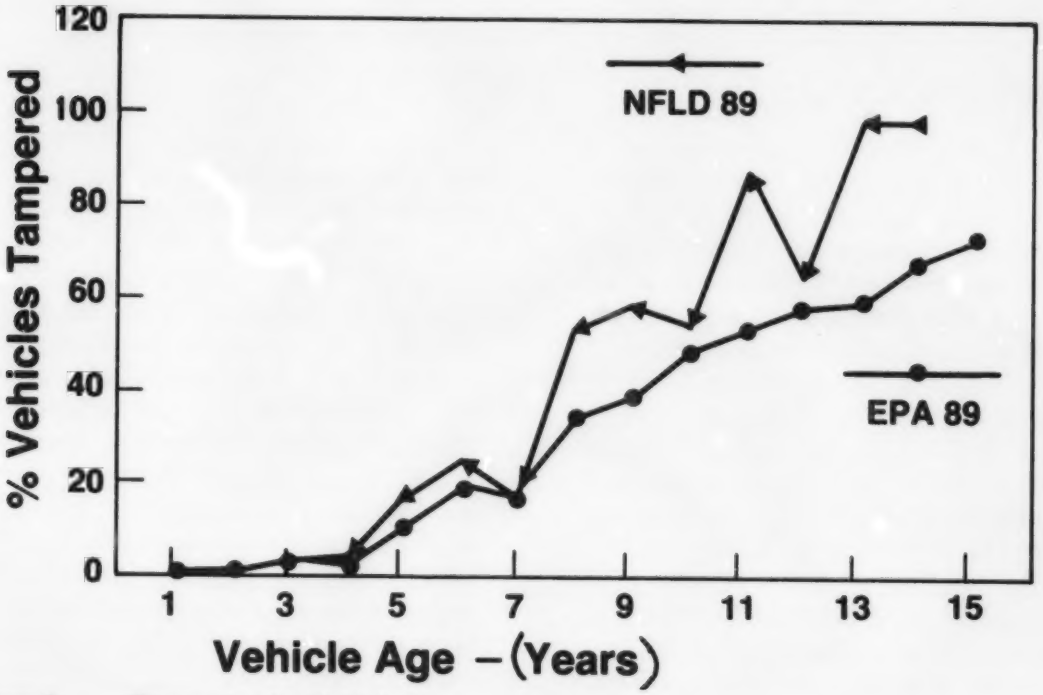

Figure 3 **Tampering by Vehicle Age**

Section 9

Conclusions

The tampering inspection and idle exhaust emissions measurement results from 13 Canadian vehicle inspection clinics reveal significant numbers of "gross emitters" and an equally significant level of tampering with emissions control components.

For most clinics and most components, the tampering rates and the numbers of vehicles with "high" emissions are equal to or greater than those collected during surveys of the in-use fleet in the United States.

Vehicle emissions are a major source of air pollution in urban centres in Canada. The results from these clinics confirm that in the urban centres involved, many vehicles are emitting pollutants well in excess of their design specifications.

The effectiveness of emissions control systems in reducing the overall impact of vehicle emissions on air quality is seriously impaired in urban centres in Canada by insufficient maintenance and/or deliberate tampering.

Anti-tampering legislation, which makes it illegal to remove or otherwise disable the originally installed pollution control systems on motor vehicles, is required in all provinces. In areas with air pollution problems resulting from excess motor vehicle emissions, there should be some form of enforcement program to support such legislation.

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Appendix

Survey Form

1.0 Explanations of Survey Form

An attempt has been made to incorporate the suggestions received after the June 1986 clinics. Figure 1 is the latest composite, one-sheet survey form. This form is recommended for future inspection clinics.

The items, as numbered on the form, are described below. The numbers correspond to an Environment Canada database that is used to collate and analyze the clinic data.

2.0 Essential Data

Several items on the survey form are essential for post-clinic data analysis. Data accuracy with respect to original emission control equipment installed on a vehicle cannot be verified without this information. The essential items include:

No. 1 - MAKE - the manufacturer's name (e.g., Toyota) or the name of a major company division (e.g., Buick).

No. 2 - MODEL - although not as essential as item no. 1, the correct identification of the model (e.g., Capri) can aid data verification.

No. 3 - MODEL YEAR - since the emission control technology installed on new vehicles can change from one year to the next, the information recorded for each vehicle is useless without the model year.

No. 10 - DISPLACEMENT - the emission control equipment installed can also vary with engine size within a particular model year.

No. 14 - TRANSMISSION - as for engine displacement, the emission control equipment installed can vary with the type of transmission installed on the vehicle.

Note: The VIN (No. 12) and the Engine Family Code (No. 13) are also very useful in vehicle equipment identification but are often difficult to locate and record accurately.

3.0 Component Condition Code

To facilitate data processing and recording, codes have been assigned to identify the observed status of the components listed on the Survey Form (Table 1). The codes shown are similar to those used for the U.S. EPA tampering surveys.

Note: to speed data entry, the "Y" code for "yes or component present with all connections in place" could be entered with a check mark.

Additional codes (in brackets on the Survey Forms) were used for those items that could not be classified into the above categories. Personnel with limited training should record in plain language rather than misuse these codes.

4.0 Description of Items on Survey Form

For all items on the survey form, a data recorder may prefer (for accuracy) to enter a

VEHICLE INSPECTION CLINIC SURVEY FORM

80. Number: DA_____ 90. Date:__ June, 1990 100. LOCATION: DARTMOUTH, NOVA SCOTIA

1. _____ MAKE (GM, Ford, Toyota, etc. and/or Pontiac, Buick, Mercury)
2. _____ MODEL or SERIES (Acadian, Stanza, F150, etc.)
3. _____ MODEL YEAR 4. _____ Licence Plate (PROVINCE ONLY)
5. _____ Type (C=Car,T=Truck) 6. _____GVWR (trucks only) 6a. lbs __ or kgs __
7. _____._____ ODOMETER READING (x1000) 7a. UNITS: mi __ or km __
9. _____ FUEL USED - ASK MOTORIST (L,U,or UL = uses and mixes both leaded & unleaded)
10. _____ DISPLACEMENT 10a. UNITS: ____ CID (Cubic Inch) or ____ Litres
11. _____ NUMBER CYLINDERS (1,2,3,4,5,6,8,10,12,99=Rotary)
12. _____ VIN (Record number from the left)
13. _____ ENGINE FAMILY number or code
14. _____ TRANSMISSION TYPE (M3,M4,M5,M8,AT)
15. _____ U.S.A. SPECIFICATION LABEL (N,Y,?)
16. _____ Label lists CATALYST (Y,N,2W,3W,2 cats,NL=no label,9)
17. _____ CATALYST Condition on inspection (0,Y,4,6,7,9,?)
18. _____ CARB BARRELS (0,1,2,3,4,?,N= no carb)
19. _____ CARB had SEALS or CAPS (0,LC=limit caps,S=Seals,?)
20. _____ SEALS or CAPS Condition on inspection
21. _____ FUEL INJECTION (0,Y,MP=multi-port,TB=throttle body,?)
22. _____ TURBO (0,N,Y,?) is vehicle turbo equipped
23. _____ EGR VALVE OR SENSOR condition
24. _____ CLOSED LOOP COMPUTER FEEDBACK (0,Y,N,6,9= problems)
25. _____ O2 SENSOR is it hooked up?
26. _____ ENGINE CHECK LIGHT IS ON? (0,Y,ON,?)
27. _____ PCV condition (0,y,3,4,5,6,7,9,?)
28. _____ THERMOSTATIC AIR CLEANER (0,Y,3,4,5,6,7,9,INV=inverted top,SP=stovepipe disconect or missing)
29. _____ EVAP CANNISTER and HOSES (0,Y,3,4,5,6,7,9,?)
30. _____ AIR PUMP (0,Y,4,5,6,7,9,?) 31. _____ AIR PUMP BELT (0,Y,7,8,9,?)
32. _____ AIR injection,aspiration, or pulse air system (0,Y,4,5,6,7,9,?)

CODES

N = No or None or Negative
Y = Yes or component present
0 = Not originally equiped
1 = Correct function verified
2 = Electrically disconnected
3 = Vacuum disconnected
4 = Mechanical disconnect
5 = Incorrectly routed hose
6 = Modification
7 = Removed or missing item
8 = Misadjusted (not on spec)
9 = Malfunction, Deterioration
? = cannot determine or find

IDLE EXHAUST EMISSIONS MEASUREMENT RESULTS

33. LOW_____ RPM 33a. HIGH_____ RPM

34. LOW_____ HC (PPM) 34a. HIGH_____HC

35. LOW_____ CO (%) 35a. HIGH_____ CO

36. _____ EXHAUST SYSTEM INTEGRITY (Y=no problems heard,EL=leaks,4,6,7)
37. _____ FUEL CAP (Y,6,7,9) 38. _____ FUEL CAP SEAL (Y,6,7,9,?)
39. _____ FUEL INLET RESTRICTOR (0,Y,1,4,6,7,9,?)
40. _____ TANK FUEL LABEL (0,Y,7,9=label painted over)
41. _____ DESIGNATED FUEL as per TANK LABEL (U=unleaded; none=L=leaded; D = Diesel) (Y,N)
43. _____ PLUMBTESMO lead test result(PP=Positive,NP=Negative)
44. COMMENTS:

Figure 1 Vehicle Inspection Clinic Survey Form

Table 1 Suggested Survey Form Codes

Augmented EPA Code		Description
O	-	Not originally equipped.
N	-	No or None or Negative.
Y	-	Yes or component present and all connections in place.
1	-	Correct function tested and verified (i.e. includes Y).
2	-	Electrically disconnected.
3	-	Vacuum disconnected.
4	-	Mechanically disconnected, (i.e. linkage has been removed but bulk of hardware still installed).
5	-	Incorrectly routed hose.
6	-	Modification.
7	-	Removed or missing item.
8	-	Misadjusted item.
9	-	Broken or malfunctioning because of damage or deterioration (not deliberate tampering).
?	-	Cannot determine (e.g. if the component was ever installed).
A	-	Stock equipment.
B	-	Non-stock.
D	-	Add-on equipment.
Z	-	Other.

written description rather than one of the codes. The following describes the items listed on the Survey Form:

80 Number. Vehicles are numbered sequentially as they are inspected. This number may be preceded by a site or city identifying letter. Example: DA001 = Dartmouth clinic, vehicle 001.

90 Date. Record the date the vehicle is inspected.

100 Location. The location of the clinic.

1. Make. The full name or common abbreviation of the vehicle manufacturer.

2. Model. Record the model name plus any identifying numbers and letters.

3. Model Year. Vehicle model year. Sources: ask the driver; list from the vehicle door post label; decode from the VIN.

4. License Plate. Province abbreviation.

5. Vehicle Type. Coded as: C = car, T = truck.

6. GVWR. Gross Vehicle Weight Rating in pounds (lbs) or kilograms (kg).

7. Odometer. Check off kilometres or miles and record the odometer reading in thousands. Ask driver to confirm the

odometer mileage, particularly with older vehicles.

8. Dash Label. Displays the fuel required. A check mark or Y on this item indicates that a dash label is still on the vehicle. Note there is no legal requirement for a dash label and therefore it cannot be used as proof of fuel type. (Excluded from latest form.)

9. Fuel Used - Ask Motorist. Ask the driver what fuel is normally used in the vehicle. Coded: L = leaded, U = unleaded, LU = combination or alternates leaded and unleaded, A = alcohol blend, AL = alternates leaded and alcohol blend, AU = alternates unleaded and alcohol blend, C = CNG - compressed natural gas, D = diesel, M = neat methanol, P = propane, Z = other.

10. Displacement. Record the value listed on the underhood label. Check either CI (cubic inches) or Litres.

11. Number Cylinders. Coded as: 3, 4, 5, 6, 8 or Z = other, such as a rotary engine.

12. VIN. Record the number on the driver's side of the dash under the windshield or on the driver's door post. Record beginning at the left. Since 1981, all VIN are 17 characters long. The tenth character from the left indicates the model year (Table 2).

13. Engine Family. As recorded on an underhood label. The engine family codes are usually alphanumeric but vary drastically by manufacturer. Before the clinic, have inexperienced data recorders check a number of sample vehicles.

14. Transmission Type. Coded: M3 = manual 3 speed, M4 = manual 4 speed, M5 = manual 5 speed, M8 = dual range manual, A = automatic. A breakdown of the number of automatic transmission speeds has been dropped because of the confusing designators used by some manufacturers.

Table 2 VIN Model Year Codes

Year	Code*
1980	A
1981	B
1982	C
1983	D
1984	E
1985	F
1986	G
1987	H
1988	J
1989	K
1990	L
1991	M
1992	N
1993	P
1994	R
1995	S
1996	T
1997	V
1998	W
1999	X
2000	Y
2001	1
2002	2
2003	3
2004	4
2005	5
2006	6
2007	7
2008	8
2009	9
2010	A
2011	B
2012	C

* For 1981 and newer vehicles, the Model Year character must be the tenth character from the left in the Vehicle Identification Number (VIN). Since 1981, all Vehicle Identification Numbers have been 17 characters long.

15. U.S.A. Specification Label. Record: N = No; Y = Yes, a label states U.S. specification; or ? = cannot find the label.

16. Label Lists Catalyst. The vehicle was originally catalyst-equipped - as listed on a label. Coded: NL = no label; Y = Yes, there is a label that indicates a catalyst; N = there is a label, but it is without a catalyst indication; or 9 = there is a label but it is too damaged to read.

17. Catalyst Condition on Inspection. Assign the code for the observed condition of the catalytic converter, including whether it is missing or bypassed. Normally this is just a check that the catalyst is on the vehicle and connected. Since most catalysts are encased in stainless steel, they are often in better condition than the rest of the exhaust system and little can be determined from an external examination.

18. Carb Barrels. Coded: 0, 1, 2, 3, or 4 barrel, or ? = the vehicle has a carburetor but the number of barrels could not be determined.

19. Carb had Seals or Caps. Indicate whether the vehicle was originally equipped with plastic caps on the idle mixture screws to limit carburetor adjustments; S = the vehicle was originally equipped with metal plugs or seals to prevent engine parameter maladjustment.

20. Seal or Caps Condition. Assign the code for the observed condition of the carburetor limiter caps or seals.

21. Fuel Injection. Coded: N = no fuel injection; MP = multi-point fuel injection; TB = throttle body fuel injection; Y = yes, fuel injection but cannot discern the type; Z = other type.

22. Turbo. Is the vehicle equipped with a turbocharger?

23. EGR Valve or Sensor. The Exhaust Gas Recirculation (EGR) System directs a portion of the exhaust gases back into the cylinders to reduce NO_x emissions in the exhaust gas. The standard EGR configuration consists of a vacuum line from the carburetor or throttle body to a sensor [the cold temperature override switch(CTO) used to detect engine operating temperature to activate the EGR valve] and another vacuum line from the sensor to the EGR valve. Assign the code for the observed condition of the EGR valve, sensor, and hoses.

24. Closed Loop Computer Feedback. Coded: 0 or Y to indicate whether the vehicle is equipped with a computer system; or 9 = the motorist reports having problems with the vehicle's computer system.

25. O_2 Sensor. The Oxygen Sensor located in the exhaust system controls the air-fuel mixture going into the engine of vehicles equipped with three-way catalytic converters. A vehicle may have an O_2 sensor even though it does not have a catalytic converter, but all closed loop computer feedback systems will have O_2 sensors.

26. Engine Check Light. Is the vehicle equipped with an engine checklight and is it on? Coded: N = not originally equipped; Y = vehicle has an engine

check light but it is not on; L = vehicle has engine light and it is on.

27. PCV. Positive Crankcase Ventilation (PCV) system - prevents crankcase emissions by purging the crankcase of blowby gases that lead between the piston rings and the cylinder wall in the combustion chamber under high pressures. Assign the code for the observed condition of the PCV system.

28. Thermostatic Air Cleaner. The Heated Air Intake provides warm air to the carburetor during cold engine operation. Assign the code for the observed condition of the thermostatic air cleaner system. Additional codes: SP = the stovepipe hose is missing or is disconnected; INV = the top cover of the air cleaner has been inverted.

29. EVAP Cannister and Hoses. The Evaporative Control System (ECS) captures vapours from the fuel tank and carburetor. Some systems have only two lines: from the fuel tank to the canister, and from the canister to the carburetor or air cleaner (for purging the canister). Other systems have a third line connected to the carburetor. Many canisters are concealed in the fender wells. Assign the code for the observed condition of the EVAP Control System.

30. Air Pump. Two types of air injection systems are currently used. One type uses a belt-driven air pump to direct air through a control valve and into the exhaust manifold. The other type is a Pulse Air Injection Reaction (PAIR) system, which uses an aspirator located in the air cleaner to supply air to the exhaust manifold. For the purposes of this report, "Air Pump" consists of the air pump and control valve. Assign the code for the observed condition of the air pump.

31. Air Pump Belt. Assign the code for the observed condition of the air pump belt.

32. Air Injection, Aspiration, or Pulse Air System. Assign the code for the observed condition of the non-air pump, air injection system.

33. Idle Exhaust Emissions. Low. High. Record the rpm readings at which the low and high idle exhaust emission measurements are recorded.

34. HC (ppm). Exhaust gas HC concentration (in ppm) at low idle and high idle.

35. CO (%). Exhaust gas CO concentration (in percent) at low idle and high idle.

36. Exhaust System Integrity. The condition of the exhaust system is coded. EL = leaks or the system has major leaks.

37. Fuel Cap. The fuel cap seals the fuel tank and prevents evaporative emissions during normal operating conditions. Record if the cap is present.

38. Fuel Cap Seal. Inspect the rubber or plastic seal to see if it is intact. Use "?" if the seal is present but its condition is doubtful.

39. Fuel Inlet Restrictor (unleaded fuel only). The restrictor is designed to prevent the introduction of a leaded fuel nozzle into a vehicle requiring unleaded fuel.

40. Tank Fuel Label. Displays the required fuel. Record whether the label is still present. If present, but painted over,

use code 9. Since the label is not always fixed to the outside surface of the vehicle, it may be necessary to obtain a key from the driver in order to check inside a locked covering door.

41. Designated Fuel as per Tank Label. Record the fuel type listed on the Tank Fuel Label. Coded: L = none or leaded fuel, U = unleaded gasoline, D = diesel fuel.

42. Fuel Sample Taken. Indicates whether a fuel sample for later lead analysis was taken. (Excluded from this form.)

43. Plumbtesmo Test. Plumbtesmo paper is used to check for the presence of lead deposit in a vehicle exhaust pipe. PP = positive. A positive indication is a change to pink or violet coloration and indicates a reaction to lead. NP = Negative. No reaction on the plumbtesmo paper is recorded as negative.

44. COMMENTS: Two lines are provided on the form to record anything unusual about the vehicle or any qualifications of test results.